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Diagnostic contribution of cytological specimens obtained from biopsies during gastrointestinal endoscopy in dogs and cats

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1 **Diagnostic contribution of cytological specimens obtained from biopsies during**
2 **gastrointestinal endoscopy in dogs and cats**

3
4 **Summary**

5
6 **Objectives:** The aims of this study were to compare cytological samples obtained from endoscopic
7 biopsies using ‘imprint’ and ‘squash’ techniques, and to evaluate the potential value of cytology
8 compared to histology in reaching the diagnosis.

9 **Methods:** Eighteen dogs and five cats undergoing endoscopy for chronic gastrointestinal signs were
10 prospectively included. Imprint and squash samples were obtained from one biopsy and then
11 analysed. Comparison between cytology and histology was performed using Cohen’s kappa
12 coefficient.

13 **Results:** Appropriate samples for cytological evaluation were most often obtained with the squash
14 technique (96% of the cases vs. 68% with the imprint technique). The diagnoses obtained with
15 cytological samples and by histology, considered as the gold standard, were compared. The same
16 diagnosis was obtained with the squash technique in 65% of the cases. Furthermore, cytology was
17 considered complementary to histology for gastric spiral organisms and mast cells identification.

18 **Clinical significance:** These results suggest that squash cytology obtained from endoscopic
19 biopsies of the gastrointestinal tract could provide relevant and additional information to histology
20 in dogs and cats. Further studies are needed to confirm these findings.

21
22 **Keywords:** cytology; endoscopy; gastrointestinal tract; imprint; squash

23 **Introduction**

24 Endoscopy is commonly used in veterinary gastroenterology to assess macroscopic lesions of the
25 mucosa and to obtain targeted samples (Washabau *et al.* 2010). Histology remains the current gold
26 standard to achieve a definitive diagnosis for infiltrative and structural diseases. However,
27 histological results are usually only available a few working days after endoscopy due to the time
28 required for laboratory processing. Moreover, some abnormal findings such as organisms present
29 within the surface mucus can be lost during the actual process and therefore misdiagnosed (Jergens
30 *et al.* 1998).

31 Cytology is commonly used in veterinary medicine, and different techniques have been described
32 (Cohen *et al.* 2003, Bonfanti *et al.* 2006, Ballegeer *et al.* 2007). However, lesions differ in their
33 ability to exfoliate, thus creating a discrepancy between 'exfoliative lesions' (which often lead to a
34 reliable cytological diagnosis) and 'poorly exfoliative lesions' (which are generally non-diagnosed
35 with cytology) (Cohen *et al.* 2003).

36 Only a few studies have focused on the diagnostic contribution of cytological samples obtained
37 from the digestive tract of dogs and cats (Tobey *et al.* 1988, Jergens *et al.* 1998, Bonfanti *et al.*
38 2006, Riondato *et al.* 2014, Mangelsdorf *et al.* 2015). The aims of this prospective study were to
39 compare the abilities of 'imprint' and 'squash' techniques to provide valid cytological samples from
40 biopsies obtained during gastrointestinal endoscopy in dogs and cats, and to evaluate the potential
41 value of cytology compared to histology in reaching the definitive diagnosis.

42

43 **Materials and methods**

44 This prospective study included dogs and cats presented for gastrointestinal symptoms and which
45 underwent a gastrointestinal endoscopy between March 2012 and March 2013 at XXX Hospital.
46 Cases were included only if biopsies, concurrent squash and imprint preparations for cytology, and
47 a conclusive histopathology report, were available. Signalment and clinical signs were recorded.

48

49 The endoscopy was performed under general anaesthesia with a GIF-160 Olympus gastroscope,
50 using FB-240K Olympus forceps for biopsies. At least five biopsies from each area of interest (i.e.,
51 stomach and proximal duodenum for upper alimentary tract, distal ileum and colon for lower
52 alimentary tract) were collected in separate cassettes, fixed in 10% formalin and then routinely
53 processed for histopathological analysis. An additional biopsy was used to obtain cytological
54 specimens with two techniques. First, the ‘imprint’ specimen was obtained by imprinting the biopsy
55 sample on a glass slide several times, using a 25 G needle to gently hold the sample. Then the
56 ‘squash’ specimen was obtained by crushing the biopsy between two slides, and pulling them apart
57 without smearing. The slides were then sent to the laboratory for cytological analysis, separately
58 from the formalin jars.

59 The biopsies were stained with haematoxylin, eosin and saffron (HES), which are the routine stain
60 used for all biopsies in our laboratory. They were reviewed by board certified pathologists from the
61 Pathology Department of XXX, and interpreted according to the current guidelines of the WSAVA
62 International Gastrointestinal Standardization Group (IGSG) described elsewhere (Day *et al.* 2008).
63 The presence of organisms was also recorded. Biopsy samples of less than 3mm or without lamina
64 propria were considered of insufficient quality and the cases were excluded.

65 Cytological samples were stained with May-Grünwald-Giemsa. All the slides were reviewed by a
66 single ECVF-diplomate (XXX) in a blinded manner at the end of the recruitment process. The
67 pathologist had access to the submission form (history and clinical signs) but was blinded to the
68 histological results. The cytological samples were analyzed using a method adapted from Jergens *et*
69 *al.* (1998) and Andreasen *et al.* (2009). The following categories were identified: inflammatory
70 cells, atypical and neoplastic cells, epithelial clusters, gastric spiral organisms (GSO), bacterial
71 flora, haemorrhage, debris/ingesta, and mucus. A cell count mean was calculated for each category
72 from at least 10 fields in well spread areas of the slide, and was then classified in a grading system
73 similar to that of Jergens *et al.* (1998) (Table 1). Samples with a grade 2 or less for epithelial
74 clusters were considered non-representative of the organ and were thus classified as ‘non

75 diagnostic'. Samples presenting poor preservation or numerous artefacts that precluded further
76 interpretation - such as crushed cells - were also excluded from further analysis.
77 For each case, the diagnostic conclusions for both the cytological and histological analyses were
78 classified into one of the categories described in Table 2, based on the predominant pathological
79 findings, in order to allow comparison of the cytological and histological diagnoses. The cytological
80 diagnosis obtained by either the imprint or squash technique, as compared with histopathological
81 analysis (considered as the gold standard) was assessed by statistical analysis. The agreement
82 between cytology and histology was determined by Cohen's Kappa coefficient. The techniques
83 were considered in agreement if both concluded to the exact same diagnosis, as per Table 2. The
84 different kappa (κ) values were scored as follows: very poor for $\kappa < 0$, poor for $0 < \kappa < 0.2$, fair for
85 $0.21 < \kappa < 0.4$, moderate for $0.41 < \kappa < 0.6$, good for $0.61 < \kappa < 0.8$ and excellent for $0.81 < \kappa < 1$ (Landis &
86 Koch 1977).

87

88 **Results**

89 Twenty-three cases, including 18 dogs and five cats, met the inclusion criteria. The ages ranged
90 from one to 16 years (from one to 13 years in dogs and from four to 16 years in cats). There were
91 eight females (seven dogs and one cat) and 15 males (11 dogs and four cats). All the cats were
92 domestic shorthairs, whereas the dogs were of various breeds: three French Bulldogs, three Jack
93 Russell Terriers, three crossbreeds, two German Shepherds, one Labrador Retriever, one Rhodesian
94 Ridgeback, one Boxer, one Weimaraner, one Parson Terrier, one Lhasa Apso and one West
95 Highland White Terrier.

96 Clinical presentation was variable but included at least one of the following signs: vomiting (17
97 cases), diarrhoea (seven cases), inappetence (five cases), weight loss (five cases), lethargy (four
98 cases), haematochezia (two cases), retching (two cases), melaena (one case), tenesmus (one case),
99 and constipation (one case).

100 Eighteen cases had biopsies taken from the stomach (fundus in 11 cases, antrum in one case, and
101 both fundus and antrum in six cases). Seventeen cases had biopsies taken from the small intestine
102 (duodenum only in 13 cases, ileum only in three cases and both duodenum and ileum in one case).
103 Six cases had biopsies taken from the large intestine (colon in five cases and rectum in one case). In
104 total, 48 sites were collected during the course of the study. Histopathological analysis resulted in
105 24 diagnoses because one case was diagnosed with two distinct conditions; they are presented in
106 Table 3 (see online).

107 For the cytological evaluation, 95 specimens were examined (48 slides obtained with the squash
108 technique, and 47 slides with the imprint technique - one slide of small intestine was lost during the
109 laboratory processing). Only 4% of the cytological samples obtained by squash technique (2/48)
110 were considered as 'non diagnostic', based on an insufficient number of epithelial cell clusters, as
111 described above. For the imprint technique, 32% of the samples (15/47) were considered as 'non
112 diagnostic'. All diagnostic specimens obtained with the imprint technique (32/47) were
113 also diagnostic with the squash technique. All 'non diagnostic' samples were excluded from further
114 statistical evaluation, in order to focus on the agreement between cytology and histopathology when
115 sample quality was good enough to reach a diagnosis.

116 Squash cytology and histology gave the same results in 65% of the cases (30/46). Agreement
117 between the two techniques was considered 'moderate' ($\kappa=0.48$ [0.32; 0.65]). This agreement was
118 'fair' for the imprint technique ($\kappa=0.39$ [0.2; 0.58]). Squash and imprint techniques led to the same
119 cytological result in 84% of the 32 specimens for which imprint cytology was diagnostic. The
120 conclusion reached for the remaining specimens (5/32) with the imprint technique was 'within
121 normal limits', whereas it was 'abnormal' with the squash technique. The overall agreement
122 between the two cytological techniques was considered 'good' ($\kappa=0.75$ [0.52; 0.98]). The
123 agreements calculated for each part of the digestive tract are summarized in Table 4.

124 Organisms were observed in nine cases. Gastric spiral organisms were found in two cases on both
125 the histological and squash samples, in three cases on histological samples only, and in three cases
126 on squash samples only (Fig. 1A and 1B). They were also observed in three cases on imprint
127 samples, and the squash technique was also diagnostic for each of them. In one dog, the histological
128 analysis revealed amastigotes forms of *Leishmania* spp. in the stomach, ileum and colon, whereas
129 the two cytology techniques only revealed them in colonic samples.

130 The cases with gastric samples were retrospectively reviewed for presence of mast cells. These cells
131 were never observed on the HES-stained histological samples, as gastrointestinal mast cells can be
132 more difficult to identify with conventional HES-stain (Ramsay *et al.* 2010). Conversely, mast cells
133 were found on cytological samples obtained from 4/5 cases where GSO had been diagnosed by
134 cytology (at a level of one cell per field at x400 magnification) (Fig. 1A). Mast cells were also
135 found in another case for which GSO had only been detected by histology. Mast cells were never
136 found in cases other than those diagnosed with GSO.

137

138 **Discussion**

139 In 1998, Jergens *et al.* described perendoscopic techniques (cytobrush and biopsy imprint) to obtain
140 cytological smears. They reported that the accuracy of cytology was satisfactory and they
141 recommended taking samples for cytology in adjunction to biopsies during endoscopy. Eight years
142 later, Bonfanti *et al.* (2006) reported that direct impression smears of biopsies obtained from
143 gastrointestinal lesions appeared to be more accurate than ultrasound-guided FNA in diagnosing
144 digestive tumours by cytological examination. More recently, Riondato *et al.* (2014) demonstrated
145 the reliability of cytological examination of squash preparations from endoscopic gastric biopsies to
146 diagnose canine gastric adenocarcinomas.

147 Our study demonstrated that the cytological smears obtained by ‘squash’ technique were of better
148 quality than those obtained by ‘imprint’ technique (4% vs. 32% of non diagnostic samples due to
149 insufficient quality, respectively). Furthermore, in all cases for which the imprint samples agreed
150 with the histological diagnosis, the same diagnosis was obtained with the squash technique. The
151 good quality of squash samples for cytology has also been reported in another recent study
152 (Mangelsdorf *et al.* 2015). The discrepancy between the two might be explained by the actual
153 technique. When an imprint smear is prepared, the biopsy sample is applied several times on a slide,
154 but leads only to the deposition of superficial cells from the sample. With the squash technique, the
155 sample is crushed on the slide, allowing cells from deeper layers of the biopsy to be deposited on
156 the slide. However, the clinician must pay attention to the thickness of the smear and avoid cell
157 mounds that would be uninterpretable for the pathologist.

158 The overall agreement between cytology (with the squash technique) and histopathology was 65%,
159 which was considered moderate ($\kappa=0.48$ [0.32; 0.65]) and was consistent with a previous
160 comparative study of cytology and histology techniques (Cohen *et al.* 2003). The terminology
161 associated with kappa’s values is derived from a study by Landis and Koch (1977), but this
162 terminology could be misleading to the clinician. Due to the small number of cases included in our
163 study, it is hard to say whether some diseases are more likely to be identified than others with
164 cytology. Nevertheless, only one case led to a significant disagreement, where the conclusion with
165 squash cytology was neutrophilic gastritis, whereas it was diagnosed as lymphoma with
166 histopathology, and the imprint technique was inconclusive. Although lymphoma can usually be
167 identified by cytology due to the ability of neoplastic cells to exfoliate, in our case, the squash
168 sample might only have caught the inflammatory reaction associated with the tumour (Bonfanti *et*
169 *al.* 2006). Regarding other cases of disagreement, cytology appeared normal or the conclusion was
170 an inflammatory process, as with histopathology, but a different cell population was identified
171 (eosinophilic instead of lymphoplasmacytic, lymphoplasmacytic instead of neutrophilic, and
172 lymphoplasmacytic instead of eosinophilic, respectively with cytology and histology, in one case

each). In conclusion, squash cytology appears interesting as a first diagnostic approach, but histopathology remains necessary. Considering that cytology is generally faster than histology to obtain results, squash samples may help the clinician to initiate an appropriate treatment more rapidly, especially in the case of neoplastic disease such as lymphoma.

For the small intestine, histology and squash cytology led to the same diagnosis in 82% of the 17 cases. Cytology also gave the best diagnostic agreement at this site in another study (Jergens *et al.* 1998). Paradoxically, the agreement between the two techniques in this particular location, as calculated by the kappa coefficient, was poor ($\kappa=0.15$ [-0.07; 0.38]). In our study lymphocytic-plasmacytic enteritis, as demonstrated in Fig. 2A and 2B, was the condition most commonly diagnosed by histology (n=13/17) and was often correctly identified by cytology (n= 9/12 for the imprint technique and n=13/13 for the squash technique) (Table 3 – see online). However other less commonly encountered conditions (such as eosinophilic enteritis or non inflammatory fibrosis) were not correctly identified by cytology (n= 0/4 for both imprint and squash techniques). The disagreement between cytology and histology in diagnosing such conditions explains the low value of the kappa coefficient. A future study focusing on inflammatory bowel disease could be useful to confirm the diagnostic contribution of a cytological examination using squash preparations obtained from gastro-intestinal biopsies in this particular situation.

In three cases, gastric spiral organisms were only observed in squash cytology, and were not observed in the corresponding histological slides. It is unlikely that these organisms were initially absent from the histological samples because both biopsies for cytological and histological examinations were taken from the same area of the stomach. The potential of cytology in detecting GSO has already been reported in other studies, and different explanations can be proposed (Happonen *et al.* 1996, Jergens *et al.* 1998). First, spiral bacteria are found in the surface mucus of the stomach. This mucus is likely to be eliminated during manipulation of the histological sample, leading to organism loss. Secondly, special stains (such as Warthin-Starry stain) are generally

198 required to recognize GSO because spiral organisms are poorly stained with HES. Conversely, they
199 are easily seen with the standard cytological stain (May, Grunwald and Giemsa). To conclude and
200 providing this finding is confirmed in a larger cohort of cases, it appears that cytology can help in
201 detecting *Helicobacter* infection in the cases where these organisms are missed on histology.

202 In our study, mast cells were observed in 5 cases of gastritis. They were only detected by cytology
203 and never by histology. This was expected, as mast cells in the gastrointestinal tract are usually well
204 stained with conventional cytological stains whereas their identification by histopathology can be
205 more challenging with conventional HE stains and requires specific stains (e.g., Giemsa, toluidine
206 blue) (Ramsay *et al.* 2010). More interestingly, we noticed a close association between the presence
207 of mast cells and GSO. In human medicine, mast cells are often seen in the gastric mucosa in
208 association with *Helicobacter pylori*, and recent studies have documented their involvement in the
209 initiation and promotion of mucosal oedema, attraction of neutrophils within the mucosa and
210 epithelial cells apoptosis (Nakajima *et al.* 2004, Hofman *et al.* 2007, Caruso *et al.* 2011). Further
211 studies focusing on this association are needed, as they could contribute to a better understanding of
212 the pathologic role - if any - of GSO in chronic gastritis in dogs and cats.

213 Neoplastic processes were diagnosed in five cases by histopathology (high-grade lymphoma in four
214 cases, as demonstrated in Fig 3B, and colonic adenoma in one case) (Table 3 – see online).

215 However, only two lymphomas were identified by cytology (both imprint and squash techniques, as
216 demonstrated in Fig 3A). For the other cases, cytological analysis was either not conclusive or led
217 to a false diagnosis (neutrophilic gastritis in one case, and carcinoma in another case). This was
218 unexpected, as round cell tumours such as lymphomas are usually considered as ‘well-exfoliating’
219 lesions. Similarly, the sensitivity of cytology (squash smear technique) to diagnose low-grade
220 alimentary lymphoma was low in a recent study (Mangelsdorf *et al.* 2015). However, a better
221 sensitivity is expected to diagnose high-grade alimentary lymphoma. Indeed, in the study by
222 Bonfanti *et al.* (2006), both sensitivity and specificity were scored as 100% when diagnosis of
223 gastrointestinal lymphoma was based on cytological examination of impression smears (obtained

224 from surgical or post-mortem biopsies). In our study, cytological samples were obtained from a
225 single endoscopic biopsy. This probably explains the poor diagnostic contribution of cytology in
226 cases of lymphoma in our study. A further study, focused on lymphoma cases and using more
227 biopsies to obtain squash preparations, will be required to confirm this hypothesis.

228 Our study has several limitations. The small number of cases and the diversity of the diagnoses
229 make generalization difficult. In particular, further studies involving a larger number of patients
230 could be useful to see if some diseases are more likely to be diagnosed by cytology than others.
231 Only one single biopsy was collected for both cytological techniques, and the squash specimen was
232 always obtained after performing the imprint specimen. It is possible that this had a negative
233 influence on the quality of the squash specimen. Different pathologists were involved for
234 interpretation of histopathological slides, and although they all followed the current published
235 guidelines (Day *et al.* 2008), this limited the standardization of the results.

236 The primary aim of our study was to obtain preliminary results regarding the interest of cytology
237 compared to histology. For this reason, we performed only one slide for each cytology technique to
238 limit the number of additional biopsies taken from the patients, whereas histological diagnosis was
239 based on at least five biopsy samples from each area. Obviously, increasing the number of
240 cytological samples is likely to improve the agreement rate between cytology and histology and this
241 could be investigated further based on the results of the current preliminary study.

242 Our study included no ‘control population’ of healthy dogs and cats, for ethical reasons. This is
243 certainly a limiting factor in comparing the sensitivity and specificity of cytology and histology of
244 the gastrointestinal tract. However, the purpose of this study was mainly to identify the value of
245 cytology as an adjunct to histology, considered as the gold standard to achieve a definitive diagnosis
246 for structural diseases.

247

248 **Conclusions**

249 This pilot prospective study shows that cytological examination of squash preparation obtained
250 from endoscopic gastrointestinal biopsies can be of interest in gastrointestinal disease investigation.
251 The technique is easy, quick and cost-effective to perform, and provides preliminary results which
252 can help the clinician to initiate a treatment pending the histopathological analysis. Furthermore,
253 cytology may be a useful adjunct for finding organisms (i.e., GSO). Although these are only
254 preliminary results, further studies focusing on the squash technique and a larger number of cases
255 would be of interest to determine more accurately the place of cytology in gastrointestinal disease
256 diagnosis in dogs and cats.

257

258 **Conflict of interest statement**

259 The authors disclose no conflict of interest. None of the authors has any financial or personal
260 relationships that could inappropriately influence or bias the content of the paper.

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305 **Figure legends**

306 Fig. 1A. Stomach, dog. Gastric spiral organisms (arrowheads) and a mast cell (arrow). The strands
307 of eosinophilic material (chromatin) in the background are artefacts. Cytology, squash preparation,
308 May-Grünwald-Giemsa stain. Bar = 20 µm. Insert: detail of spiral organisms at higher
309 magnification.

310 Fig. 1B. Mucosa, stomach, same dog as Fig. 1A. Gastric spiral organisms in the lumen of a crypt.
311 Histology, Warthin-Starry stain. Bar = 20 µm.

312

313 Fig. 2A. Stomach (pylorus), dog. Several small lymphocytes (arrowheads) close to epithelial cell
314 clusters (arrows): chronic lymphocytic gastritis. Cytology, squash preparation, May-Grünwald-
315 Giemsa stain. Bar = 20 µm.

316

317 Fig. 2B. Mucosa, stomach (fundus), same dog as in Fig. 2A. Increased number of lymphocytes and
318 plasma cells in the lamina propria: chronic lymphoplasmacytic gastritis. Histology, haematoxylin-
319 eosin-saffron stain. Bar = 20 µm.

320

321 Fig. 3A. Stomach (pylorus), dog. Large lymphoblasts predominate: gastric lymphoma. Cytology,
322 squash preparation, May-Grünwald-Giemsa stain. Bar = 20 µm.

323

324 Fig. 3B. Mucosa, stomach (pylorus), same dog as in Fig. 3A. Large lymphoblasts infiltrate the
325 lamina propria and the lamina muscularis: gastric lymphoma. Histology, haematoxylin-eosin-
326 saffron stain. Bar = 20 µm.

Table 1

Grading system used for cytological analysis. Adapted from Jergens et al. (1998) and Andreasen et al. (2009).

Categories	Description	Definition of grades used	
Inflammatory cells	Neutrophils, eosinophils, lymphocytes,	Grade 0: no cell	Per field at
	plasma cells, macrophages, mast cells	Grade 1: 1 cell	40x-
Atypical/neoplastic cells		Grade 2: 2 cells	Objective
		...	
		Grade 7: ≥ 7 cells	
Gastric Spiral Organisms (GSO)		Grade 0: absence	
Bacterial flora	Rods and cocci	Grade 1 to 2: presence of	
Haemorrhage	Presence of peripheral blood	mild amount	
Debris/ingesta	Plant material, darkly pigmented	Grade 3 to 4: presence of	
	particulate matter	moderate amount	
Mucus	Diffusely basophilic mucinous	Grade 5 to 7: presence of	
	material or rounded mucinous globules	marked amount	
Epithelial clusters		Grade 0: none	Per field at
		Grade 1: 1 to 2 clusters	10x-
		Grade 2: 3 to 4 clusters	Objective
		Grade 3: 4 to 5 clusters	
		Grade 4: 6 to 7 clusters	
		Grade 5: 7 to 8 clusters	
		Grade 6: 9 to 10 clusters	
		Grade 7: > 10 clusters	

Table 2

Diagnostic categories defined for both cytological and histological analyses to allow comparison of the techniques.

Normal	
Inflammation	Lymphoplasmacytic
(defined by the predominant cell population)	Eosinophilic
	Neutrophilic
	Histiocytic
Non inflammatory fibrosis	
Neoplasia	Lymphoid
	Epithelial
	Mesenchymal
	Neuroendocrine

Table 3

Histological and cytological results obtained for the 23 cases included in the study.

Species	Breed	Sex	Age	Histological diagnosis	Cytological diagnosis	
					Imprint	Squash
Cat	DSH ¹	Male	11	Gastric lymphoma	Gastric lymphoma	Gastric lymphoma
	DSH	Male	11	Rectal lymphoma	Non conclusive	Non conclusive
	DSH	Male	16	Gastric lymphoma	Non conclusive	Neutrophilic gastritis
	DSH	Female	12	Lymphoplasmacytic gastroenteritis	Eosinophilic gastritis and lymphoplasmacytic enteritis	Eosinophilic gastritis and lymphoplasmacytic enteritis
	DSH	Male	4	Lymphoplasmacytic gastritis + GSO ²	Non conclusive	Normal stomach + GSO
Dog	West highland white terrier	Male	13	Lymphoplasmacytic enteritis	Slide not available	Lymphoplasmacytic enteritis
	French bulldog	Female	3	Neutrophilic gastritis + GSO, normal duodenum	Normal stomach, lymphoplasmacytic enteritis	Normal stomach, lymphoplasmacytic enteritis
	Lhasa apso	Female	5	Normal stomach, lymphoplasmacytic enteritis, normal colon	Normal	Normal stomach, lymphoplasmacytic enteritis, normal colon
	Jack Russell terrier	Male	10	Gastric lymphoma, lymphoplasmacytic enteritis	Gastric lymphoma, lymphoplasmacytic enteritis	Gastric lymphoma, lymphoplasmacytic enteritis
	Rhodesian ridgeback	Female	10	Colonic adenoma	Non conclusive	Colonic carcinoma

¹ DSH: domestic shorthair

² GSO: gastric spiral organisms

Parson terrier	Male	12	Lymphoplasmacytic gastroenteritis	Stomach non conclusive, lymphoplasmacytic enteritis	Normal stomach + GSO, lymphoplasmacytic enteritis
Labrador	Female	1	Lymphoplasmacytic gastroenteritis + <i>Leishmania spp.</i> amastigotes	Stomach non conclusive, lymphoplasmacytic enteritis + <i>Leishmania spp.</i> amastigotes	Normal stomach, lymphoplasmacytic enteritis + <i>Leishmania spp.</i> amastigotes
Labrador	Male	4	Lymphoplasmacytic gastroenteritis + GSO	Normal stomach, lymphoplasmacytic enteritis	Lymphoplasmacytic gastroenteritis
German shepherd	Male	9	Lymphoplasmacytic enteritis	Normal	Lymphoplasmacytic enteritis
Boxer	Male	10	Normal stomach, lymphoplasmacytic enteritis (small and large intestine)	Stomach non conclusive, lymphoplasmacytic enteritis, normal colon	Stomach non conclusive, lymphoplasmacytic enteritis (small and large intestine)
Crossbred	Male	3	Lymphoplasmacytic gastritis + duodenal fibrosis	Normal stomach + GSO, lymphoplasmacytic enteritis	Lymphoplasmacytic gastroenteritis + GSO
German shepherd	Male	7	Normal stomach, eosinophilic enteritis	Normal stomach and duodenum	Normal stomach and duodenum
Weimaraner	Female	12	Normal stomach, lymphoplasmacytic enteritis	Stomach non conclusive, lymphoplasmacytic enteritis	Normal stomach, lymphoplasmacytic enteritis

Crossbred	Female	11	Eosinophilic enteritis + colonic fibrosis	Ileum non conclusive, normal colon	Lymphoplasmacytic enteritis, normal colon
French bulldog	Male	3	Normal stomach +GSO, lymphoplasmacytic enteritis	Normal stomach + GSO, lymphoplasmacytic enteritis	Normal stomach + GSO, lymphoplasmacytic enteritis
French bulldog	Female	7	Neutrophilic gastritis + GSO and lymphoplasmacytic enteritis	Stomach non conclusive, normal duodenum	Normal stomach, lymphoplasmacytic enteritis
Jack Russell terrier	Male	11	Lymphoplasmacytic gastroenteritis	Normal stomach, lymphoplasmacytic enteritis	Normal stomach, lymphoplasmacytic enteritis
Jack Russell terrier	Male	12	Lymphoplasmacytic gastritis	Lymphoplasmacytic gastritis + GSO	Lymphoplasmacytic gastritis + GSO

Table 4

Agreement between cytological techniques and histology for the different parts of the digestive tract.

Organ	Technique	Number of specimens	Number of specimens considered 'diagnostic' ¹	Number of agreements between cytology and histology ²	Kappa value
Stomach	Imprint	24	13	7	0.42 [0.18; 0.65]
	Squash	24	23	12	0.37 [0.18; 0.56]
Small intestine	Imprint	17 ³	15	10	0.04 [-0.3; 0.37]
	Squash	18	18	14	0.15 [-0.07; 0.38]
Large intestine	Imprint	6	4	2	0.27 [-0.24; 0.78]
	Squash	6	5	4	0.72 [0.23; 1.22]
Total	Imprint	47	32	19	0.39 [0.2; 0.58]
	Squash	48	46	30	0.48 [0.32; 0.65]

¹ Number of specimens of sufficient quality to be interpretable

² Amongst 'diagnostic specimens'

³ One of the 18 imprint specimens was lost during laboratory process











